SCI PROTOCOL EMULATION

1.1 GENERAL DESCRIPTION

This section briefly describes the SCI RDACS communication protocol for reference purposes only. The appropriate SCI documentation should be consulted for complete details of the RDACS protocol.

The SCI RDACS protocol is a bit synchronous protocol. Each SCI RDACS message is 31 bits in length. Multiple 31 bit messages may be sent sequentially by a remote to complete a response message exchange. The protocol may be used in a point to point environment or a multidrop configuration. The protocol may be used in either a full or half duplex operation. Communications security is provided by sync bit checking and a 7-bit Bose'-Chaudhuri (BCH) error code. Also control requests are protected by a select-before-execute message exchange.

All communication exchanges in SCI RDACS protocol are initiated by the host. The remote cannot initiate any exchange with the host nor can the remote directly address or communicate with another remote. The remote transmits a response to the host for all valid messages sent by the host and addressed to the remote. The remote will not respond to any messages not containing a valid sync bit or BCH.

Messages from the host to the remote are always 31 bits long. Responses from the remote are one or more 31-bit messages constituting a single remote response.

A typical RDACS message exchange between a host computer and the Comm-Troller is shown below.

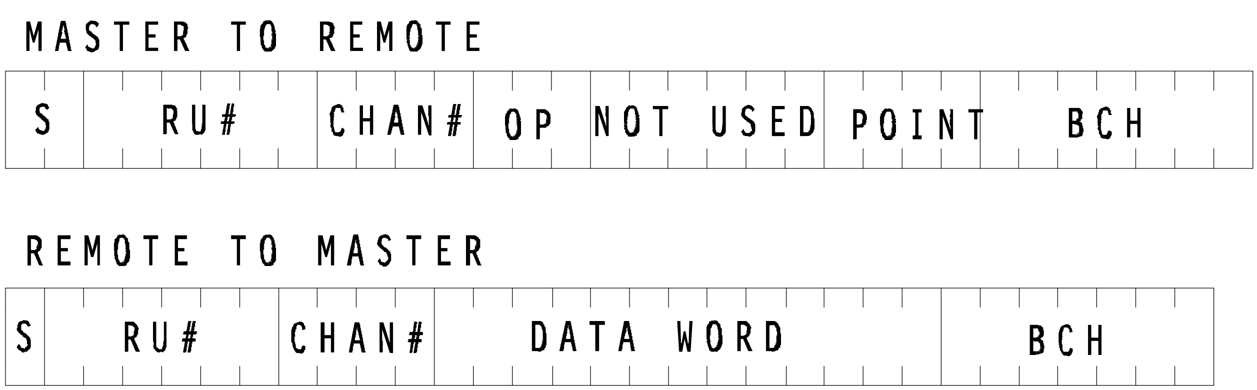

Figure A-1 Random Access Data Req.

The sync bit is always a one (1) and is further described in Section 1.4.1. The remote unit (RU) number is a 6 bit binary value representing a number from 0 to 63, the maximum allowable RU number. The request message channel and point fields are 4-bit binary numbers which define the RDACS channel/point to be used. The op code is a 3-bit field instructing the remote on the action to perform. The op codes and their meanings are described in Section 1.2 below. The response data field is 13 bits of data as read from the specified channel/point. The last 7 bits of the message are always the BCH code.

1.2 MESSAGE TYPES

SCI RDACS protocol provides for 3 message exchange types using 8 op codes (0-7). These types are Command, Data Streaming and Random Access Data Request. Figures A-1 thru A-3 illustrate the basic message formats.

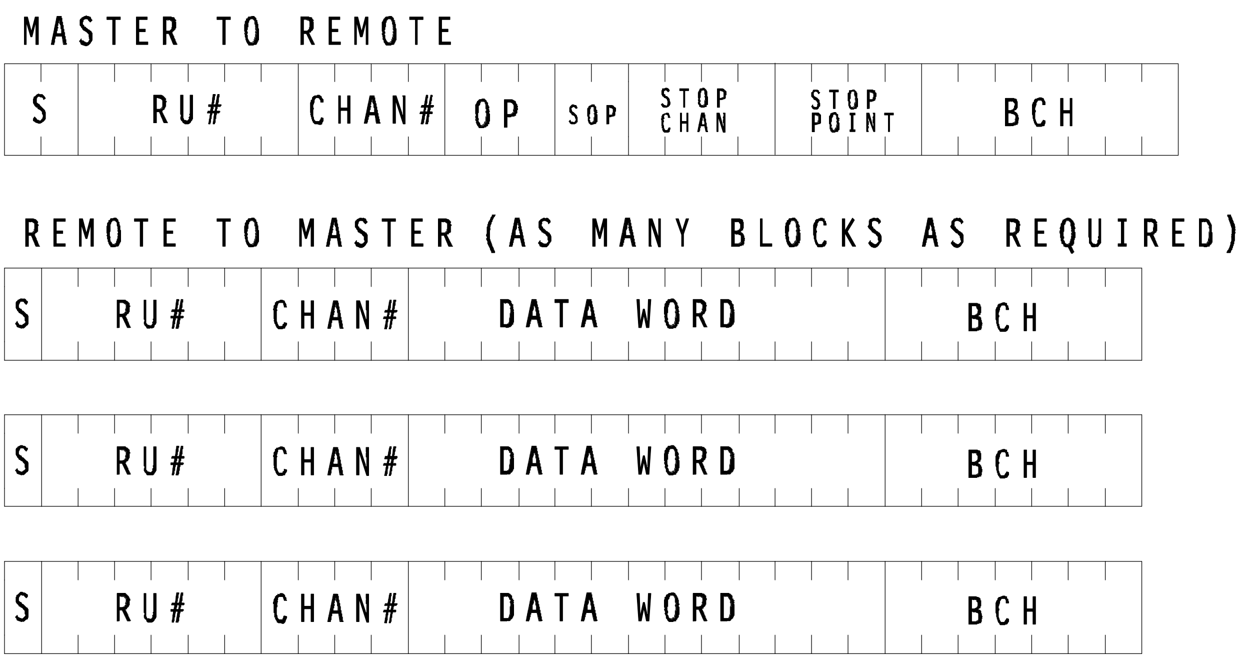

Figure A-2 Streaming Data Request

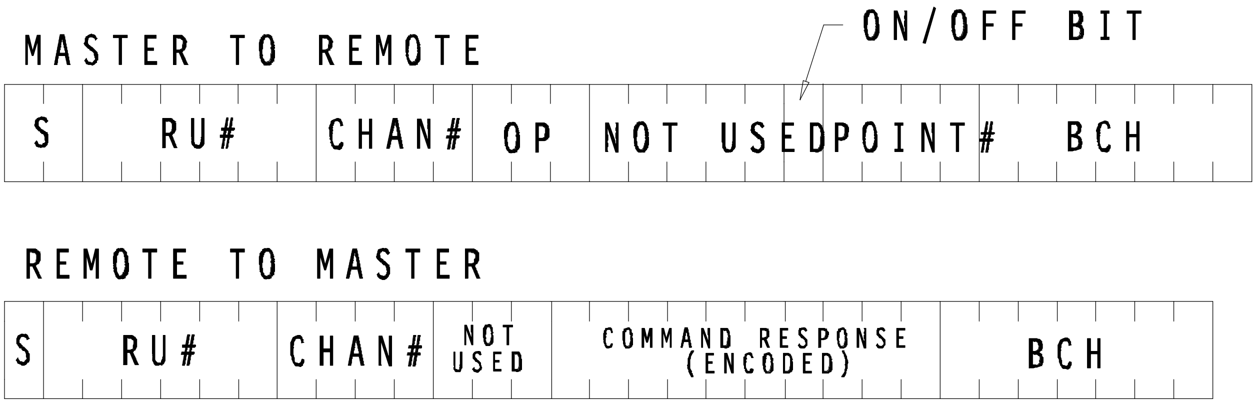

Figure A-3 Command Message

Op Code	Description	Implemented
0	Analog Input	Y
1	Digital Input	Y
2	Cal 0 Digital	Y
3	Cal 1 Digital	Y
4	Cal 0 Analog	Y
5	Data Output	Y
6	Cal 1 Analog	Y
7	Streaming	Y
sub op 0	Stream Analog	Y
sub op 1	Stream Discrete Status	Y
sub op 2	Stream Multiplex Status	N
sub op 3	Stream Accumulators	Y

Figure A-4 RDACS Op Codes

The command message exchange is used to control both analog and digital outputs of the RTU. Command messages for analog output (setpoint) may be used in a "select before execute" type of exchange depending on the setting of an option flag in the configuration header. Command messages to digital points always employ the "select before execute" mode of operation For the RDAC unit the execute message is merely the re-transmission of the control command. That is, the first output command is interpreted as a select message only. If the next command received is exactly the same as the select message the control action will be executed. If the second message is not the same then the control operation will be terminated. The control request message for discrete outputs contains the address of the remote, the discrete output point number and an on/off status for the output. The remote echoes the request messages with the selected output point identified by setting one and only one of the bits in the 10-bit command response field if the on/off bit is on. If the on/off bit is off then any pending control action for the selected channel will be reset. If the control request message is for an analog output channel then the 10 bits representing the setpoint value are echoed in the command response field.

The data streaming message is used to request the value of multiple analog inputs, status inputs or accumulator inputs. The host request contains the address of the remote, the type of data requested, the starting channel number and the ending channel number and point. The remote responds with a sequential stream of data blocks until all the data requested has been transferred.

The random access data request is used to request the value of a single channel of information from the remote. The request message contains the address of the remote, the data type (as specified by the op code) and the channel/point address. The remote responds with a message containing the channel number and the data. Accumulators are not accessible by random access messages.

1.3 DATA ADDRESSING

SCI RDACS protocol provides the capability to directly address any measurement point in the system or to stream classes of data. The point address capability is arranged as a matrix of 16 channels and up to 10 points per channel providing 160 directly addressable points. However the method of handling digital and analog data allows the full utilization of the matrix of points on a non interference basis for either digital or analog information. The op code in the random access request and special op code in streaming requests provide the differentiation. It should be noted that one channel for status contains 12 status input points.

Random access command and setpoint message types use the channel and point number to directly address the desired data. Data streaming requests use the start channel, stop channel and stop point to address a series of sequential points.

1.4 MESSAGE SECURITY

The SCI RDACS protocol provides message security checks through the use of sync bits and a Bose'-Chaudhuri (BCH) cyclic error code. The SCI RDACS message security provides error detection but no error correction.

1.4.1 Sync Bit

The sync bit indicates the start of a message and is different for host transmissions and remote transmissions. The sync bit (in the transmission from the remote to the host) is always one bit length and is checked at the 90% point of the bit time. If the bit is at a 1 for 90% of a bit time, it is considered a valid sync bit and the remainder of the bits are clocked in. If the logic 1 level does not last for at least 90% of a bit time, the sync bit is not considered valid.

The sync bit (in the transmission from the host to the remote) is a "1" for 2 bit times. The bit is checked at the 90% point, 130% point and the 170% point. A bit value of "1" at all three test points indicates a valid sync bit.

1.4.2 Bose'-Chaudhuri Calculation

RDACS utilizes a 31, 24 Bose'-Chaudhuri (BCH) cyclic error detection code for message security. The basic information content of a message is 24 bits and the error detecting code is 7 bits. This 7-bit error detection code is the remainder resulting from dividing the 24 bits of message information by the primitive polynomial x7 + x3 + 1. This 7-bit remainder is added to the 24 bits of message information to form the 31 bit message. The receiving entity divides the first 24 bits of the incoming message by the same primitive polynomial forming a 7-bit remainder. If this remainder is equivalent to the last 7 bits received then no detectable errors have occurred. If the remainder does not agree with the last 7 bits received an error in transmission has occurred and the message is discarded.

1.5 SCI CONFIGURATION TABLE

The SCI configuration table layout is shown in the following tables.

BYTE	DESCRIPTION
0	RU Number
1	Number of PLC's
2,3	Not Used
4	Baud Rate
5	Not Used
6	Not Used
7,8	Control De-select Time (10mSec/count)
9	Select/Select Option
10	Set Point Ch# (255 = not defined)
11	Set Point Ch# (255 = not defined)
12	Set Point Ch# (255 = not defined)
13	Set Point Ch# (255 = not defined)
14	Not Used
15	Swap Enable Flag (1=enable)
16,17	RTS/CTS Delay Time (6.3uS/Count)
18,49	Not Used

Figure A-5 Configuration Header

BYTE	DESCRIPTION
0	PLC Address
1	# Bytes per Discrete Input Card
2	# Discrete Input Cards
3,4	Start Address Discrete Input Cards
5	# Bytes per Analog Input
6	# Analog Inputs
7,8	Start Address Analog Inputs
9	# Bytes per Accumulator Input
10	# Accumulator Inputs
11,12	Start Address Accumulator Inputs
13	# Bytes per Discrete Output Card
14	# Discrete Output Cards
15,16	Start Address Discrete Output Cards
17	# Bytes per Analog Output Card
18	# Analog Output Cards
19,20	Start Address Analog Outputs
21,24	Not Used
25	# Bytes per Analog Input
26	# Analog Inputs
27,28	Start Address Analog Inputs

Figure A-6 PLC Data

1.5.1 SCI Configuration Header

The Remote Unit Number to which the Comm-Troller will respond when communicating with the RDACS host is defined by the first byte (byte #0) in the configuration header section. This entry is a 6-bit binary number which is right justified in the byte. The valid range for this number is from 0 to 63 (00000000 to 00111111).

The number of PLCs in the system is defined by byte #1. This entry is a 4 bit binary number which is right justified in the byte. The valid range for this number is from 1 to 8 (00000001 to 00001000). This number is used to determine the number of Data Configuration Blocks to read.

Bytes #2 and 3 are reserved for use as a Radio Delay Timer. The current implementation of the RDACS protocol in the Comm-Troller ignores these bytes.

Byte #4 is used to define the baud rate which will be used while communicating to the RDACS Host. This entry is a binary number which is right justified in the byte. Valid selections are: 300 baud (00000100), 600 baud (00000101), 1200 baud (00000110) and 2400 baud (00001000)

Bytes #5 and 6 are reserved for use in other Comm-Troller implementation and are ignored.

Bytes #7 and 8 are used to define a "Control De-Select Time". This feature is not found in RDACS remotes. The timer is used to qualify the execute command from the RDACS Host. If the execute command is not received within the time-out period the Comm-Troller will abort the current select operation and return to normal operation. The timer is a 16-bit binary value with each count equal to 10 msec. Byte 7 is the most significant byte and byte 8 the least significant. This field must be set to a non-zero value.

Byte #9 is used to enable the select/execute option for analog outputs. If this byte is equal to zero then the analog output command will be executed as soon as it has been received. If the byte is non-zero then the Comm-Troller will not issue the command to the PLC until an execute command has been received. For the RDACS protocol the execute command is an exact copy of the command.

Bytes #10, 11, 12 and 13 are used to define up to four analog output channels. Since the same output command is used for both analog and digital controls but the response depends on the type of output module installed in the addressed channel, the Comm-Troller must be informed so it will know where to direct the output in the PLC. The 4-bit channel number (right justified) for up to 4 analog outputs is placed in these bytes. The Comm-Troller will search the contents of these bytes starting with byte #10. If the channel address contained in the command matches any of the 4 locations the command will be directed to an analog output channel. If no match is found the command is directed to a digital output channel. If the match is found in byte #10 then the first analog output card is used; if the match is found in byte #11 then the second analog output card is used and so on for up to 4 outputs.

Byte 14 is not used and should be set to zero.

Byte 15 is a "Swap Enable Flag". If this byte is non-zero any failure detected by the Comm-Troller while communicating with the PLC will result in an automatic switch-over to a backup PLC. The backup PLC address must be address $0B_{HEX}$. If the backup PLC subsequently fails the Comm-Troller will attempt to switch back to the primary unit. If this byte is a zero then a switch will not be attempted.

Bytes 16 and 17 are used to define the modem RTS/CTS delay time. The timer value is equal to the binary count stored in bytes 16 and 17 times 6.313 uSec.

1.5.2 PLC Data Configuration for RDACS Protocol

The PLC Data Configuration section(s) are each 57 bytes long. There is one table required for each PLC connected to the Comm-Troller. Up to 8 PLCs can be connected to each Comm-Troller. The number of sections to read is defined by byte #1 in the header section.

Byte #0 is used to define the address of the PLC on the data highway. This address will be used to read the data as defined by the remaining bytes in the Configuration table.

Byte #1 is used to define the number of bytes of data for each status input channel. This byte must be set to 2 (00000010) for this application. The RDACS protocol sets the number of points per status input channel to 12. The Comm-Troller forms the 12-bit response by reading two bytes for each status input channel and then masking off the upper bits of the most significant byte. The bytes will be read most significant byte first.

Byte #2 is used to define the number of status input channels assigned to this PLC. This byte is a binary number in the range of 0 to 32 (00000000 to 00100000). The first 16 channels are defined as "point 0" and the last 16 channels as "point 1" in RDACS terminology.

Bytes #3 and 4 define the starting address in the PLC for the status input data. The data contained in bytes 3 and 4 will be inserted exactly as read in the address portion of the read data command when the PLC is polled for data.

Byte #5 is used to define the number of bytes of data for each analog input channel. It must be set to 2 (00000010) for this application. The RDACS protocol sets the number of bits of data for each analog input channel to 13. The Comm-Troller forms the response by reading two bytes for each analog input channel and then masking off the upper bits of the most significant byte. The bytes will be read most significant byte first.

Byte #6 defines the number of analog input channels assigned to this PLC. This byte is a binary number in the range of 0 to 119 (00000000 to 01110111). The first channel is assigned as channel 0 point 0, the second as channel 0 point 1 and so on. The eleventh channel is assigned as channel 1 point 0. This progression continues up to the maximum channel 11 point 9. If additianal analog input channels are required they are defined using data type 6 (bytes 25 thru 28) as described below.

Bytes #7 and 8 define the starting address for the analog input data. Since all the data for all data types within a PLC is read with a single poll request, this address must be exactly equal to the starting address of the status input channels plus 2 times the number of status input channels. That is, the data must be contiguous.

Byte #9 defines the number of bytes of data for each accumulator input channel. It must be set to 4 (00000100) for this application. The Comm-Troller treats all accumulator inputs as if they were 24-bit accumulators. The first 2 bytes are used to form the least significant 12 bits of the response and the second 2 bytes the most significant 12 bits. In both cases the high order 4 bits of the first byte in each pair is ignored. The RDACS channel/point number is mapped to the accumulator input section in the same fashion as the analog inputs. The first word is channel 0 point 0, the second word is channel 0 point 1, the third word is channel 1 point 0 and so on up to the maximum of channel 15 point 1.

Byte #10 defines the number of accumulator input channels. This number must be a binary number in the range of 0 to 16 (00000000 to 00010000).

Bytes #11 and 12 define the start address of the accumulator input data. Since the data must be contiguous this address must be exactly equal to the start address of the analog inputs plus 2 times the number of analog inputs.

Byte #13 defines the number of bytes of data for each digital output channel. For the RDACS application byte #13 must be set to 2 (00000010).

Byte #14 defines the number of digital output channels. This byte must be in the range of 0 to 16 (00000000 to 00010000). The RDACS control outputs have ten (10) points per channel; the Allen-Bradley has 16 points per card. The RDACS outputs will be mapped to the first ten points of each Allen-Bradley card. Six (6) points per card will not be used by the Comm-Troller.

Bytes #15 and 16 define the start address of the control output channels. Since the data must be contiguous this address must be exactly equal to the start address of the accumulator inputs plus 4 times the number of accumulator inputs.

Byte #17 defines the number of bytes of data for each analog output (setpoint) channel. For the RDACS application byte #17 must be set to 2 (00000010).

Byte #18 defines the number of setpoint channels defined for this PLC. This byte is a binary number in the range of 0 to 4 (00000000 to 00000100). Bytes 10 thru 13 in the header section define the channel numbers assigned to the analog outputs.

Bytes #19 and 20 define the start address of the setpoint data. Since the data must be contiguous this address must be exactly equal to the start address of the control output channel plus 2 times the number of control outputs.

Bytes #21 thru 24 are not used in the RDACS Comm-Troller.

Byte 25 is used to define the number of bytes of data for each analog input channel for channels 12 thru 15. It must be set to 2 (00000010) for this application. The RDACS protocol sets the number of bits of data for each analog input channel to 13. The Comm-Troller forms the response by reading two bytes for each analog input channel and then masking off the upper bits of the most significant byte. The bytes will be read most significant byte first.

Byte 26 defines the number of analog input channels (only analog inputs from RDACS cahnnels 12 thru 15) assigned to this PLC. This byte is a binary number in the range of 0 to 40 (00000000 to 00101000). The first analog input is assigned as channel 12 point 0, the second as channel 12 point 1 and so on. The eleventh channel is assigned as channel 13 point 0. This progression continues up to the maximum channel 15 point 9.

Bytes 27 and 28 define the starting address for the analog input data. Since all the data for all data tyhpes within a PLC is read with a single poll request, this address must be exactly equal to the starting address of the analog output data (setpoints) plus 2 times the number of analog output channels defined. That is, the data must be contiguous

Bytes 29 thru 56 are not used in the RDACS Comm-Troller.

1.6 JUMPER SELECTIONS FOR SCI PROTOCOL

The Comm-Troller jumper selections and EPROM selections for SCI RDACS operation is detailed in the following figure.

JUMPER	POSITION	JUMPER	POSITION
J2	1-2	J10	1-3, 11,13
J3	1-2	J11	1-2
J4	NOT USED	J12	1-2
J5	NOT USED	J13	1-2
J6	1-2	J14	1-2
J7	1-2	J15	1-2
J8	1-2	J16	1-2
J9	1-2	J17	1-2

Figure A-8 Jumper Selections for SCI

SCI Protocol Communication in on Port P3 (bototom port), Allen-Bradley Communication is on Port P2 (center port).
U13 = #127-015-X
U23 = #127-014-X
U18 = #127-016-X

Figure A-7 SCI EPROM Part Numbers

1.7 EXAMPLE CONFIGURATION FILE

The following figures detail a sample configuration file for a typical SCI protocol application. The configuration information is based on the following information:

Protocol	SCI RDACS II
PLC Type	PLC-5/15
Comm. Data	Leased Line, 1200 baud
Num. of PLCs	One
Num. of Status	240
Num. of Analogs	30
Num. of Accums.	16
Num. of Controls	16
Num. of Setpoints	1
Desired location of configuration table at word 145_{10}	
Desired starting location of data at word 0_{10}	
Desired location for Config. Table address Pointer 136_{10}	
Allen-Bradley RS232 Interface module address is 11_8	

Figure A-9 Example System Info.

1.7.1 Comm-Troller Switch Settings

The location of the word which points to the start of the configuration table must be specified by setting the three (3) address selection switches on the Comm-Troller. For this example the switch selections are:

Pointer Address= 136_{10} (decimal word address)

= 272_{10} (decimal byte address)

= 110_H (hex byte address)

Set Comm-Troller switches to 011 (least significant 0 is implied)

1.7.2 Example Table Entries

PLC WORD	
136	0122
145	0201
146	0000
147	0600
148	0100
149	C800
150	0CFF
151	FFFF
152-169	0000

Figure A-10 Example SCI Header

PLC WORD	
170	0A02
171	1400
172	0002
173	1E00
174	2804
175	1000
176	6402
177	1000
178	A402
189	0100
180	C400
181-198	0000

Figure A-11 Example SCI Data Table